

# HIGH STRESS CAPABILITY, INTERMETALLIC PHASE TITANIUM ALUMINIDE COATED COMPONENTS

## BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates to coated components having the capability to withstand high stresses and composed of the intermetallic phase titanium aluminide as material, and more particularly, to materials suitable for use in piston engines, gas turbines, exhaust gas turbochargers and the like.

Because of their good technical properties, materials based on the intermetallic phase TiAl (titanium aluminide containing 44 to 48 atomic percent of aluminum) have recently become increasingly important as moving components for, for example, piston engines or gas turbines. Compared with titanium alloys, TiAl materials have, in particular, a lower weight, a higher creep resistance, a good coefficient of thermal expansion and good thermoconductivity. Since the yield point of around 300 MPa does not fall substantially at working temperatures of up to about 700° C., the TiAl materials thus have, with respect to weight, the same specific strength as known nickel superalloys. Therefore, components made of TiAl materials are, in principle, suitable for all applications in which working temperatures of up to about 700° C. occur and in which the component should have a low weight.

A disadvantage of the known TiAl materials is that they have low resistance to oxidation and wear when exposed to friction processes. In practice, attempts have already been made to reduce the disadvantage of the low resistance to oxidation by alloying niobium into the TiAl materials, but the stability of, for example, nickel superalloys has not been achieved in this way. Moreover, the alloying-in of niobium gives rise to an increase in the cost of the TiAl material.

In order to increase the resistance to wear, it is also known to incorporate hard particles, for example composed of titanium diboride, in a material. To this end, the materials must be produced by a powder metallurgical method which is technically laborious and expensive. Moreover, with this production method, the hard material particles are present in the entire material or in the component and not only on the component surfaces at which it is intended to increase the wear resistance. In addition, subsequent machining, for example cutting, of materials permeated by hard material particles is distinctly impaired.

Metal coating of the TiAl material at the endangered surface areas by way of electroplating methods or by a metal spraying process, e.g. a plasma spraying process, usually has little practical success because the adhesion of the metal coating to the base material is too low and the metal coatings therefore frequently peel off when subjected to severe stress.

An object on which the present invention is based is to provide coated components able to withstand high stresses and based on intermetallic phase titanium aluminide as the material.

Another object is to provide a surface coating of the components with a greater resistance to oxidation and wear and a better adhesion to the base material than known coatings.

The foregoing objects have been achieved according to the present invention by coating the components

with a coating sheet of a solderable nickel-based alloy soldered on under vacuum at least portions of the component surface subjected to hot corrosion and/or operational wear, the nickel-based alloy having a melting point of below 1180° C and forming, on soldering, at least one of a metallic hard material alloy and hard intermetallic phases with the material and with itself.

We have made the surprising discovery that the surfaces of titanium aluminide components which have been coated according to the present invention have substantially greater resistance both to oxidation and to wear than the untreated surfaces of the material. The coated components are resistant to oxidation up to temperatures of about 900° C., and the resistance to wear when subjected to tribological stress is also substantially improved. This relates both to the field of application of components at a temperature of up to about 200° C. for sliding operations under the effect of lubricants, e.g. engine oil, and the field of application at higher temperatures of up to about 700° C. Hitherto components made of conventional materials which have surface coatings and armoring of special hard alloys, such as stellites or Triballoy alloys, as protection against wear have been used for these applications.

According to the present invention, at least the surface parts of the components which during operation are at particular risk of hot corrosion and/or wear are provided with a coating of a nickel-based alloy soldered on under vacuum.

Soldering of the alloy onto the material under vacuum is carried out in accordance with known technologies. In order to ensure good soldering-on of the alloy, it has proved suitable to use alloys which have a melting point of below 1180° C. In the case of nickel-based alloys which have a higher melting point, soldered coatings which adhere well to the material are not obtained when soldering on under vacuum because of a very vigorous course of reaction between the material and the alloy.

When the coated components are used in practical applications, it has been found that a coating thickness of 0.1 to 0.4 mm is sufficient to protect the components or the selected surface parts of the components against oxidation and wear. Therefore, normal soldering sheets, which are easy to handle, can be used, and a certain grinding overmeasure is also available on surfaces which have to be accurately machined.

The nickel-based alloys, of which the soldering sheets are composed, are also commercially available and known. Soldering sheets which comprise, in addition to nickel as a main constituent, 1 to 19% by weight of chromium, 1 to 3.5% by weight of boron, 1 to 10% by weight of silicon, 1 to 11% by weight of phosphorus and 0.1 to 0.7% by weight of carbon are preferably used. 1 to 35% by weight of manganese and 1 to 12% by weight of tungsten can also be added to the nickel-based alloy in order further to improve the resistance of the soldered-on coating to oxidation and wear.

A nickel-based alloy which comprises, in addition to the main constituent nickel, 6.5% by weight of chromium, 4.5% by weight of silicon, 3% by weight of boron and 2.5% by weight of iron (known in Germany under the trade name L-NiCr7Si5Fe3B3/L-Ni2 and in the USA under the standard designation ASTM/AWS B-Ni2) has preferably been used as the soldering sheet. The melting point of this alloy is about 1000° C.